CLAIMS

We claim:

1. A method comprising:

placing a substrate having a nitride layer in a reaction chamber;

providing a silicon source, an oxygen source and a boron source into the reaction chamber while delaying providing a phosphorous source into the reaction chamber to form a borosilicate glass layer over the nitride layer; and

providing the phosphorous, silicon, oxygen and boron sources into the reaction chamber to form a borophosphosilicate film over the borosilicate glass layer.

2. The method of claim 1, wherein delaying providing a phosphorous source into the reaction chamber is performed for a predetermined period of time.

3. The method of claim 2, wherein the predetermined period of time is in a range of approximately 3-30 seconds.

4. The method of claim 2, wherein the predetermined period of time is about 10 seconds.

5. The method of claim 2, wherein the predetermined period of time is selected relative to a desired nitride layer consumption amount and phosphorous and boron source concentrations present in the borophosphosilicate glass layer.

6. The method of claim 1 further comprising annealing the borophosphosilicate glass layer at a temperature in a range of approximately 700° C to 1050° C in an

ambient selected from the group consisting of steam ambient, water ambient and ambient formed by in-situ reaction of H_2 and O_2.

7. The method of claim 1 further comprising annealing the borophosphosilicate glass layer at a temperature of about 850° C in a steam ambient.

8. The method of claim 1 further comprising stabilizing individually the flows of the silicon, oxygen, boron and phosphorous sources prior to providing the sources in the reaction chamber.

9. The method of claim 1, wherein a combined weight percent of boron and phosphorous in the borophosphosilicate glass layer is about 10 weight percent.

10. The method of claim 1, wherein the borophosphosilicate glass layer comprises about 2-5 weight percent boron and about 2-9 weight percent of phosphorous.

11. The method of claim 1, wherein the borosilicate glass layer has a thickness in a range of approximately 75-150 angstroms.

12. The method of claim 1, wherein the borosilicate glass layer has a thickness sufficient to prevent a reaction of phosphorous and the nitride layer.

13. The method of claim 1, wherein the borophosphosilicate glass layer has a thickness in a range of approximately 2000-20000 angstroms.

14. A method of forming an insulating film on a substrate to reduce nitride consumption during manufacture, the method comprising:

placing a substrate having a nitride layer thereon in a reaction chamber;

providing a silicon source, an oxygen source, a boron source and a phosphorous source for chemical vapor depositing a doped silicate glass layer over the nitride layer;

stabilizing individually the flows of the silicon, oxygen, boron and phosphorous sources prior to providing the sources into the reaction chamber;

injecting the silicon source, the oxygen source and the boron source into the chamber for a predetermined period of time to form a borosilicate glass layer over the nitride layer on the substrate; and

injecting the phosphorous source into the chamber while continuing injecting the silicon, oxygen and boron sources into the chamber to deposit a borophosphosilicate glass layer over the borosilicate glass layer.

15. The method of claim 14, wherein the predetermined period of time to deposit a borosilicate glass layer over the nitride layer is in a range of approximately 3-30 seconds.

16. The method of claim 14, wherein the predetermined period of time to deposit a borosilicate glass layer over the nitride layer is about 10 seconds.

17. The method of claim 14 further comprising annealing the borophosphosilicate glass layer at a temperature in a range of approximately 750° C to 1050° C in an ambient selected from the group consisting of steam ambient, water ambient and ambient formed by in-situ reaction of H_2 and O_2.

18. A method to control nitride consumption during integrated circuit manufacture, the method comprising:

placing a substrate having a nitride layer in a reaction chamber;

providing a silicon source, a oxygen source, a boron source and a phosphorous source;

injecting the silicon, oxygen and boron sources into the reaction chamber while delaying injecting the phosphorous source in the reaction chamber for a predetermined period of time to deposit a boron-rich silicate glass film over the nitride layer; and

injecting the phosphorous source in the reaction chamber following the predetermined period of time while continuing injecting the silicon, oxygen and boron sources into the reaction chamber to deposit a borophosphosilicate film over the boron-rich silicate glass film.

19. The method of claim 18, wherein the predetermined period of time to deposit a boron-rich silicate glass film over the nitride layer is in a range of approximately 3-30 seconds.

20. A substrate processing system comprising:

a substrate holder, located within a chamber, that holds a substrate during substrate processing, the substrate having a nitride layer thereon;

a gas delivery system to introduce a reactant gas mix into the chamber to form a layer over the substrate, the gas delivery system comprising a vaporizer, a valve connected between the vaporizer and the chamber, the valve having a valve input connected to a vaporizer output and a first valve output connected to a chamber gas input and a second valve output connected to a bypass line; and a controller to switch the valve between the first valve output and the second valve output;

a pump coupled to a gas outlet to control the chamber pressure;

a thermal anneal system to reflow the layer deposited over the substrate;

the controller further to control the gas delivery system and the pump, and to control the thermal anneal system; and

a memory coupled to the controller comprising a computer-readable medium having a computer-readable program embodied therein to direct operation of the substrate processing system, the computer-readable program comprising:

instructions to control the gas delivery system to introduce a reactant gas mix including a silicon source gas, a boron source gas, a phosphorous source gas and a carrier gas into the chamber to deposit for a predetermined period of time a boron rich silicate glass film over the nitride layer followed by depositing a borophosphosilicate glass film over the boron rich silicate glass film, the instructions further to control a temperature of the reflow.

21. The substrate processing system of claim 20, wherein the predetermined period of time to deposit a boron rich silicate glass film over the nitride layer is in a range of approximately 3-30 seconds.

22. The substrate processing system of claim 20, wherein the predetermined period of time to deposit a boron rich silicate glass film over the nitride barrier layer is about 10 seconds.